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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*

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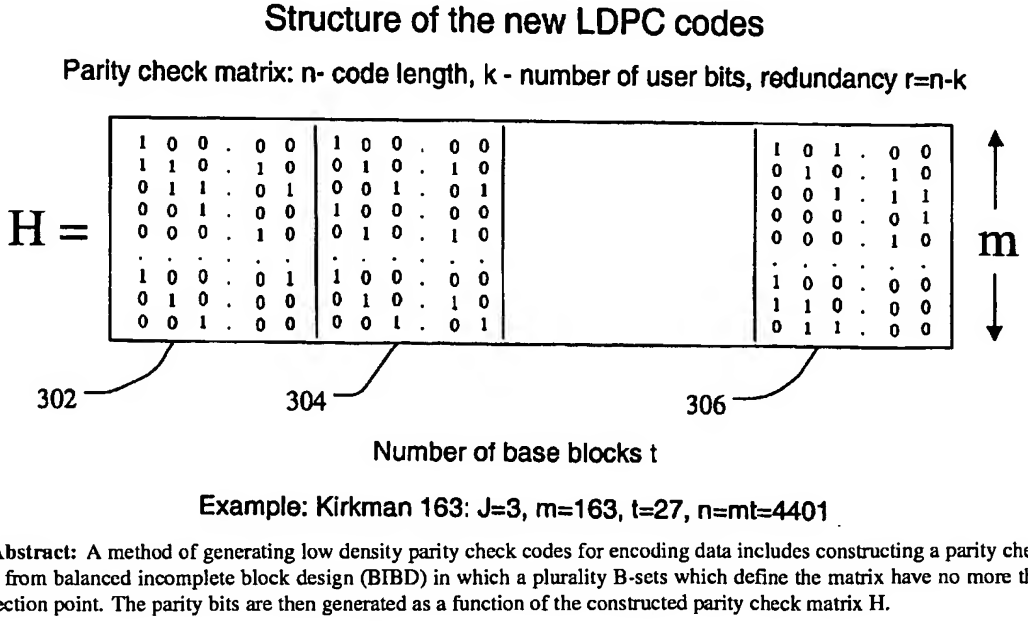
(54) Title: A METHOD AND CODING APPARATUS USING LOW DENSITY PARITY CHECK CODES FOR DATA STORAGE OR DATA TRANSMISSION



(57) Abstract: A method of generating low density parity check codes for encoding data includes constructing a parity check matrix H from balanced incomplete block design (BIBD) in which a plurality B-sets which define the matrix have no more than one intersection point. The parity bits are then generated as a function of the constructed parity check matrix H.

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AMENDED CLAIMS

[received by the International Bureau on 07 October 2002 (07.10.02);
Original claims 1 replaced by new claim 1; claims 2 and 3 cancelled;
original claims 4-18 renumbered to 2-16 (3 pages)]

1. A method of generating low density parity check codes for encoding data, the method comprising:

constructing a parity check matrix H having a balanced incomplete block design (BIBD) in which a plurality B-sets which define the matrix have no more than one intersection point, the parity check matrix H being constructed such that for each vxv sub-matrix of the parity check matrix H, v being the number of bits in each row and column of each sub-matrix, each column of the sub-matrix contains the same number of 1's as all other columns of the sub-matrix, and such that for each vxv sub-matrix of the parity check matrix H, each column after a first column is a circular shift of the first column; and

generating parity bits as a function of the constructed parity check matrix H.

2. The method of claim 1, wherein constructing the parity check matrix further comprises constructing the parity check matrix H such that each column of the matrix contains the same number of 1's as all other columns of the matrix.

3. The method of claim 2, wherein constructing the parity check matrix further comprises constructing the parity check matrix H such that no pair of columns in the parity check matrix contains two 1's at the same positions.

4. The method of claim 3, wherein constructing the parity check matrix further comprises constructing the parity check matrix H such that the BIBD is a pair (V,B), where V is a v-set and B is a collection of b k-subsets of V, each k-subset defining a block, such that each element of V is contained in exactly r blocks, and such that any 2-subset of V is contained in exactly λ blocks, and wherein λ is equal to 1.

5. The method of claim 4, wherein a (v,k,λ)-BIBD is a BIBD with v points, block size k, and index λ, and wherein constructing the parity check matrix

further comprises constructing the parity check matrix such that it has a $(v,k,1)$-BIBD.

6. The method of claim 4, wherein constructing the parity check matrix further comprises constructing the parity check matrix such that it is a has a $(v,3,1)$-BIBD.

7. The method of claim 4, wherein constructing the parity check matrix further comprises constructing the parity check matrix such that it is a has a $(v,2,1)$-BIBD.

8. The method of claim 5, wherein the parity check matrix includes t sub-matrices $[H_1\ H_2 \ldots H_t]$ such that $H=[H_1\ H_2 \ldots H_t]$, and wherein m is a column vector consisting of $(t-1)v$ data bits, generating the parity bits further comprising generating a column vector p consisting of v parity bits using the relationship $[H_1\ H_2 \ldots H_{t-1}]\times m = H_t \times p$.

9. An encoder (208, 400, 500, 600) for encoding message data with a low density parity check code, the encoder comprising:

a first matrix vector multiplier (MVM) (345, 405, 505, 605, 610) which receives a v-bit set of message data and multiplies the v bit set of message data by a first column of a first sub-matrix of a low density parity check matrix H having a balanced incomplete block design (BIBD) in which a plurality B-sets which define the matrix have no more than one intersection point, the first MVM producing a first MVM output as a function of the multiplication; and

a second MVM (360, 510, 615) which receives the first MVM output and generates parity bits by multiplying the first MVM output by the inverse of a first column of a last sub-matrix of the low density parity check matrix H.

10. The encoder of claim 9, wherein the first MVM comprises a plurality of first MVM units (345, 405, 505, 605, 610) each receiving a different v-bit set of

message data and multiplying its corresponding received v-bit set of message data by a first column of a different one of a plurality of sub-matrices of the low density parity check matrix H, the first MVM producing the first MVM output as a function of a combination of the multiplication results in each of the plurality of first MVM units.

11. The encoder of claim 9, wherein for each vxv sub-matrix of the parity check matrix H, v being the number of bits in each row and column of each sub-matrix, each column of the sub-matrix contains the same number of 1's as all other columns of the sub-matrix.

12. The encoder of claim 11, wherein for each vxv sub-matrix of the parity check matrix H, each column after a first column is a circular shift of the first column.

13. The encoder of claim 12, wherein each column of the parity check matrix H contains the same number of 1's as all other columns of the parity check matrix.

14. The encoder of claim 13, wherein no pair of columns in the parity check matrix H contains two 1's at the same positions.

15. The encoder of claim 14, wherein the parity check matrix H is a (v,k,λ)-BIBD, where a (v,k,λ)-BIBD is a BIBD with v points, block size k, and index λ, and wherein index λ is equal to one.

16. An apparatus for encoding digital information with a low density parity check code, the apparatus comprising:

an input which receives a sequence of message bits; and

means for generating parity bits as a function of the sequence of message bits and as a function of a parity check matrix H having a balanced incomplete block design (BIBD) in which a plurality B-sets which define the matrix H have no more than one intersection point.